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## Comparison of Biofuel Systems

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# Comparison of Biofuel Systems

## **Abstract**

This brochure describes an experiment that compares the soil health, water quality, biodiversity and energy production of various biofuel systems, ranging from continuous corn to native prairie

## **Disciplines**

Agriculture | Natural Resources Management and Policy | Oil, Gas, and Energy

## Why harvest native prairie for biofuel feedstock?

Annual cropping systems cover millions of acres in Iowa, stressing our key natural resources, soil and water. New biofuel feedstock systems will have to address these increasingly significant problems.

The 2007 Energy Independence and Security Act mandated the production of 36 billion gallons of renewable biofuel by 2022, with 44 percent from cellulosic sources. COBS investigates how to meet this demand with biofuel systems such as perennial native prairie that offer multifunctional benefits.

A prairie harvested for biofuel feedstock is likely to differ from the remnant or restored prairies familiar to most conservationists. Nevertheless, there are multiple advantages to using prairie for this purpose. In addition to biofuel, prairies provide: 1) habitat for wildlife, 2) refuges for beneficial insects, 3) decreased nitrogen, phosphorus and sediment movement into waterways, 4) improved soil quality, 5) a buffer against flood and drought, and 6) cultural, aesthetic and recreational values.



Photo by Meghann Jarchow

## Learn more

Visit the COBS website:  
[www.agron.iastate.edu/cobs](http://www.agron.iastate.edu/cobs)

Leopold Center Competitive Grant Project E2009-18:  
[www.leopold.iastate.edu/grants/e2009-18](http://www.leopold.iastate.edu/grants/e2009-18)

Liebman, M., M.J. Helmers, L.A. Schulte, and C.A. Chase. In press. Using biodiversity to link agricultural productivity with environmental quality: Results from three field experiments in Iowa. *Renewable Agriculture and Food Systems*.

Jarchow, M.E. and M. Liebman (2012). Nitrogen fertilization increases diversity and productivity of prairie communities used for bioenergy. *GCB Bioenergy*. Doi: 10.1111/j.1757-1707.2012.01186.x

Jarchow, M.E. and M. Liebman. (2011). *Incorporating Prairies into Multifunctional Landscapes*. Iowa State University Extension PMR 1007. [www.leopold.iastate.edu/pubs-and-papers/2011-02-incorporating-prairies-multifunctional-landscapes](http://www.leopold.iastate.edu/pubs-and-papers/2011-02-incorporating-prairies-multifunctional-landscapes)

Cover photo by Madeline Tomka



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# Comparison of Biofuel Systems

*Native prairie produces  
biofuel and protects soil,  
water and biodiversity*



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Iowa State University  
South Reynoldson Farm

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# Perennial prairies as beneficial biofuel

## What is the experiment?

The Comparison of Biofuel Systems (COBS) experiment seeks to identify and develop cropping systems that will profitably produce biofuel feedstocks while improving biodiversity and protecting Iowa's soil and water. Researchers established the experiment in 2008 on Iowa State University's South Reynoldson Farm in Boone County, Iowa. The experiment compares replicated plots of five cropping alternatives:

- Conventional corn-soybean (for grain)
- Continuous corn (for grain and stover)
- Continuous corn with rye cover crop (for grain and stover)
- Unfertilized reconstructed prairie (for biomass)
- Fertilized reconstructed prairie (for biomass)



## What have researchers found?

### *Significant biomass produced*

Estimates of the fuel yield in 2010 suggest that the fertilized prairie will produce comparable amounts of energy to the corn-soybean system, although less than the continuous corn systems. As expected, the unfertilized prairie produced the least amount of biomass in the early years of establishment.

### *Soil health preserved*

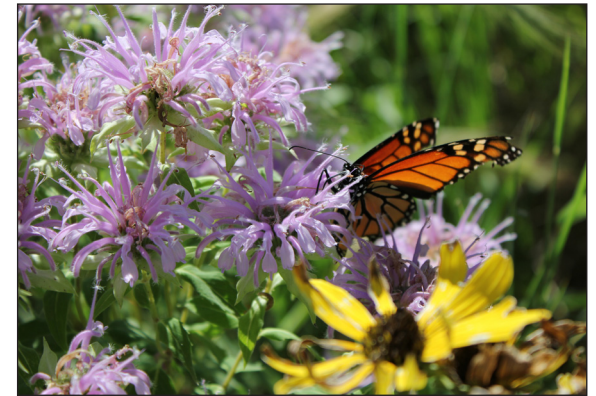
The prairie systems had eight to twelve times more roots than the corn plots in 2010, with 40 to 55 percent of their total biomass occurring belowground (compared to only three percent for corn). Deep-rooted prairie plants hold soil in place, reducing the movement of sediment, nitrate and other pollutants. They add organic carbon to the soil, enriching its fertility and water-holding capacity, which helps crops withstand drought. By including prairie in the biofuel portfolio, farmers can grow a crop that protects and improves Iowa's soil resources.

### *Water quality improved*

Researchers measure the nitrate released into tile drainage water for each of the systems. In 2010 prairie systems had almost no nitrate loss, compared to the intermediate losses in the continuous corn with rye cover crop, and high losses in the continuous corn and corn-soybean systems. The fertilized prairie released 97 percent less nitrate to drainage water compared to the corn-soybean system.

### *More research underway*

Ongoing work measures emissions of carbon dioxide and nitrous oxide, critical greenhouse gases. Emissions vary seasonally and partly depend on the timing and amount of fertilization. Researchers will also estimate the energy production potential of each system.



## Why measure biodiversity?

Biodiversity is often used as an indicator for ecosystem health. In general, diverse ecosystems are believed to have increased stability, productivity and resilience.

In this experiment researchers measured the *functional group diversity*, which shows site composition by grouping plants according to selected traits, in June and August over three years. Warm-season grasses dominated the unfertilized prairie, whereas the fertilized prairie had a more favorable composition for biodiversity with roughly equal abundances of warm-season grasses, cool-season grasses and forbs.

Previous research has found that fertilized prairies often have lower biodiversity than unfertilized prairies. However, these initial site-specific results from the COBS experiment suggest that managing a prairie with early-spring nitrogen fertilization and an annual fall harvest (after plants have reached maturity and transferred their nutrients belowground) may increase plant biodiversity as well as produce biofuel feedstock.

Photo credits: Aerial - Tom Schultz, Prairie/Butterfly - Madeline Tomka